VANCOUVER ISLAND ROOSEVELT
ELK/INTENSIVE FORESTRY INTERACTIONS

Working Plan
1981-1985

INTEGRATED WILDLIFE INTENSIVE FORESTRY RESEARCH

Province of British Columbia

A cooperative project between the Ministries of Environment and Forests

VANCOUVER ISLAND ROOSEVELT ELK/INTENSIVE FORESTRY INTERACTIONS

Working Plan
1981-1985

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Summary

Roosevelt elk ecology in regenerating forests on Vancouver Island has not been studied to date. Of particular concern are elk-forestry interactions, specifically how forestry activities might be better managed to maintain or enhance elk populations, and at the same time, reduce forest damage problems. Elk response to specific forestry manipulations will be investigated by monitoring habitat utilization, animal condition, and population parameters. Habitat enhancement in regenerating forests will also be evaluated to determine its effect on the condition of the individual, the population and the reduction of damage to commercially valuable tree species.

The emphasis of this study will be placed on determining the influences of various silvicultural practices (i.e. thinning, fertilization) on elk habitat utilization. Individuals in areas differing in silvicultural treatment will be immobilized and neckfitted radio collars will be placed on the animals. Daily monitoring of movements and habitat utilization of radio collared elk will illustrate the influences of forestry activities on home range, migratory patterns and habitat selection.

The influence of silvicultural activities on the vegetation and physical environment will be assessed by monitoring elk forage species and weather conditions in areas differing only in treatment, or in the same area prior and subsequent to treatment. The condition of individuals will be monitored using blood, fecal, and body fat indices. Population condition will be assessed by determining survival and productivity through late winter and fall aerial survey counts.

Estimations of predator density, distribution, food habits, and habitat use will be undertaken to elucidate the influence of silvicultural activities on predation in regenerating forests.

The feasibility of various habitat enhancement techniques (including forage propagation, fertilization and high-site conversion) as means of increasing survival, productivity, individual conditions, and decreasing animal damage, will be examined.

The results from this study will provide information on changes in elk home ranges, habitat utilization, migratory patterns and individual animal condition that may occur as a result of silvicultural activities. Particular land management practices can then be recommended to maintain or enhance Roosevelt elk populations in Vancouver Island regenerating forests.

A tentative budget for work to be carried out during this study is presented in Table 1.

Table 1. Tentative 5-year budget for the study of elk/intensive forestry interactions

	(Jan-Mar 81) 1980/81	Apr 81-Mar 82 1981/82	1982/83	1983/84	1984/85
Manpower					
- 2 full time	-	40 000	42 000	44 000	46 000
- 2 seasonal	-	20 000	21 000	22 000	23 000
Travel	2 000	6 000	6 500	7 000	7 500
Vehicle					
- Rental 1-4WD	-	3 000	3 500	4 000	4 500
- Rental 1 snowmachine	-	500	500	500	500
Flying Time	-	25 000	20 000	15 000	15 000
Field Equipment					
- Radiocollars	-	2 500	-	3 000	-
- Neckbands	-	-	500	-	-
- Cap-Chur gun	-	300	-	-	-
- Drugs	1 200	1 000	1 000	1 000	-
- Syringes etc.	400	100	100	-	-
- Clover traps	-	-	1 000	-	-
- Corral traps	-	-	1 000	-	-
- Snowshoes/skiis	-	400	-	-	-
- Misc.	-	200	200	200	200
Transplant costs	2 500	-	2 500	-	-
Office costs					
- paper, xeroxing	-	300	350	350	400
- mixc.	200	200	200	200	200
Lab Services					
- Blood analysis ($65/sample)	1 000	1 500	-	1 500	-
- Fecal fragment analysis ($150/diet)	-	1 800	1 800	1 800	-
- Fecal N ($5/sample)	-	2 000	2 000	2 000	-
- Forage analysis ($30/sample)	-	5 000	5 000	5 000	-
Computing Services	-	2 000	2 500	3 000	3 500
TOTAL	7 300	111 800	111 650	115 050	105 300

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1 INTRODUCTION

Roosevelt elk (Cervus elaphus roosevelti) ecology in second growth forests on Vancouver Island has not been studied to date. Major wildlife-forestry interactions and research needs associated with intensive wildlife and forest management have been examined in a problem analysis initiated by the B.C. Ministry of Forests (Ellis 1980). A subsequent problem analysis, dealing specifically with Roosevelt elk/intensive forestry interactions, provides a problem definition, reviews the unknowns, and outlines recommendations for research (Janz et al. 1980). An immediate and long term frame of reference was discussed in the problem analysis, with the intent of establishing a "baseline" dataset to identify and design appropriate study sites and treatments for testing specific hypotheses which will be the focus of the long term reference frame. This working plan outlines the research direction over the five year program, with emphasis on immediate research requirements over the next year. The following subjects, identified in the problem analysis, require immediate information collection:

a Use of present habitat types on a seasonal and diurnal basis.
b Migratory status of herds; and factors initiating migration.
c Seasonal home range delineation.
d Seasonal food habits.
e Animal condition by season.
f Plant species composition, forage quality and quantity and availability by habitat type and season.
g Preliminary population characteristics such as abundance, productivity, recruitment and dispersal.
h Predatory influences.

This information, even in preliminary form, will be used to define more specific hypotheses on elk/intensive forestry interactions. Working plans will be updated on an annual basis, incorporating the previous year's progress and results.

2 DEFINITION OF TERMS AND ABBREVIATIONS

The following terms are defined in the context of this report:

Animal condition - physical health and fitness of an individual (as indexed by body fat content etc.).

Commercial thinning - spacing activities with subsequent removal of commercial tree species for market.

Dispersal - movement of individuals into or out of populations.

High-site type conversion - reclamation of a potentially valuable under-stocked parcel of land by decreasing competition from non-commercial species and increasing stocking of commercial species.

Home range - that area traversed by an individual in its normal activities of food gathering, mating, and caring for young, over a specified period of time (daily, seasonal, lifetime).

Interplanting - planting of forage species simultaneously with planting of commercial tree seedlings.

Population - in this study, a group of animals inhabiting a particular watershed in which one or more discrete herds may exist.

Population condition or vigor - measure of the health and fitness of a population (as indexed by productivity, rate of increase, etc.).

Population response - the net results of changes in population parameters (population level, sex ratio, survival, productivity) from some perturbation(s).

Predation - with reference to elk in regenerating forests, includes direct mortality attributed to wolves, bears, cougars, and humans.

Second growth forests - immature forest ecosystem (secondary succession) resulting from logging activities; also referred to as regenerating forests or simply regrowth.

Security (hiding) cover - vegetative cover providing an animal protection from view.

Silvicultural fertilization - broadcast fertilization of an area to enhance production of commercial tree species, usually carried out after spacing activities.

Silvicultural treatments - intensive forestry activities undertaken to enhance production of commercially valuable tree species including spacing, fertilization, site conversion, underplanting, interplanting, commercial thinning, and site control (herbicides).

Spacing - thinning - reduction in the number of commercially valuable trees per unit area to decrease intraspecific competition and increase growth rates.

Spaced stand density - the density in trees per unit area remaining after spacing activities.

Species availability - includes floristic list, abundance, and accessibility in the habitat of elk forage species.

Suitable habitat - an area that satisfies particular requirements of an animal (i.e. hiding cover, thermal cover).

Thermal cover - vegetative cover enabling an animal to maintain body temperature under extreme weather conditions.

Thinning - spacing.

Underplanting - planting forage species subsequent to spacing activities.

Abbreviation	Definition
ADF	Acid detergent fiber
ASB	Air Studies Branch (Ministry of Environment)
AOAC	Association of Official Analytical Chemists
BCFP	British Columbia Forest Products
BUN	Blood urea nitrogen
CP	Crude protein
dbh	Diameter at breast height
DMD	Dry matter digestibility
FS	Forest Service
FW	Fish and Wildlife
IWIFR	Integrated Forestry-Intensive Wildlife Research
KFI	Kidney fat index
MB	MacMillan Bloedel
MOF	Ministry of Forests
N	Nitrogen
NDF	Neutral detergent fiber
NEFA	Non-esterified fatty acids
RAB	Resource Analysis Branch (Ministry of Environment)
TSB	Terrestrial Studies Branch (Ministry of Environment)
UBC	University of British Columbia

3 OBJECTIVES

3.1 Silviculture Effects on Habitat Use, Food Habits, Home Range Size and Migration

To examine the effects of silvicultural treatments on habitat utilization, food habits, home range size and migratory patterns of elk.

As with any form of habitat alteration, silvicultural activities can be expected to influence elk utilization of an area. The major forestry practises including spacing, fertilization, commercial thinning, and site conversion may influence habitat utilization, food habits, home range size and migratory patterns of elk. In order to document elk response to silvicultural activities, the approach will entail the collection of baseline information on elk inhabiting second growth forests, with subsequent monitoring of pre and post treatment and/or control vs. treatment comparisons. The following are specific sub-objectives.

3.1.1 Habit Use and Food Habits

To examine the effects of silvicultural activities on habitat utilization and food habits of elk.

It is necessary to document present elk habitat utilization in order to assess the impacts that intensive forestry practices may have on elk populations. Study of habitat use in treated and untreated second growth forests is a top priority, as these strategies ultimately dictate animal fitness and population vigour.

Changes in the available forage resulting from silvicultural activities in an area may affect food selection by elk. Food habits, data and nutrient analysis of forage species in both treated and unmanaged second growth stands will reflect the impacts of silvicultural activities on the composition and quality of elk diets. Presumably dietary intake characteristics will be reflected in animal condition and ultimately in population productivity.

3.1.2 Home Range Size

To examine the effects of silvicultural activities on the home range size of elk.

Seasonal home range size may be expected to change in response to changes in forage availability brought about by silvicultural practices. For example, if forage is restricted through spacing activities within an existing home range, home range may expand; conversely if fertilization enhances forage quality and availability within an existing home range, then home range size may be expected to decrease. Home range size can have important implications on spatial distribution of elk herds in a watershed, influencing animal density and reflecting the carrying capacity of the system.

3.1.3 Migration

To examine the effects of silvicultural activities on the timing of migration.

The initiation of migration appears to be in response to the availability and quality of forage, which can be influenced by snow conditions and temperature.

Commercial thinning and spacing activities will decrease canopy cover and may influence the timing of migration through possible changes in forage availability and snow depth. These influences may be reflected in changes in animal condition and, ultimately, survival and productivity.

3.2 Silviculture Effects on Vegetation and Physical Environment

To document the spatial distribution and characteristics of available habitat types within the study area.

Baseline information on habitat selection requires knowledge of the utilization and the various environmental attributes of available habitat types. Elk radio location information overlayed on habitat type maps (manually or computerized) will indicate animal - habitat relationships.

To investigate the influences of silvicultural treatments on vegetation (succession, species composition) and physical environmental parameters as they relate to elk.

Silvicultural treatments change the plant community. The type, magnitude and duration of vegetational changes will determine suitability for elk. Specifically, species composition, forage production, forage quality, forage availability, and cover availability will be the important characteristics of vegetation for elk. The following are a set of sub-objectives for vegetation investigations as they relate to elk.

3.2.1 Canopy Closure and Stand Density

To estimate canopy closure and stand density in mature cover patches, treated regeneration, and untreated regeneration.

Canopy closure and stem density are important stand characteristics that will influence understory production (food), snow interception (shelter), and winter forage availability (food-shelter interaction). The impact of thinning on these parameters may seem obvious, however, understory response and rates of canopy closure after thinning are poorly documented. Also, fertilization may increase the rate of tree crown growth and canopy closure.

3.2.2 Production of Key Forage Species

To measure and monitor production of key forage species in treated and untreated stands.

Productivity of forage species will ultimately determine the level of utilization that a habitat may support. Measurement of the productivity of key forage species (as determined from diet analyses), their degree of utilization (browse), and their availability should indicate whether a habitat is being utilized above or below forage capabilities.

3.2.3 Silvicultural Fertilization

To measure and monitor species composition and forage quality in fertilized and non-fertilized stands.

Silvicultural fertilization may increase nitrogen availability to understory vegetation, resulting in higher growth rates (increased forage availability), higher forage quality and possibly changes in species composition. To determine the magnitude and duration of such effects, and to assess the net impact on elk habitat, it will be necessary to monitor forage quality, availability and species composition in fertilized and non-fertilized stands.

3.2.4 Debris

To measure debris depth and decomposition rates in spaced stands differing in age at thinning, age since thinning, stand density prior to thinning and thinned stand density.

3.2.5 Snow Conditions

To monitor snow depth and density in treated and untreated stands.

Snow depth and density within stands will determine winter forage availability and elk mobility. Measurement of snow depth and density in permanent plots in thinned and unthinned stands of different ages should indicate the degree of change in these parameters attributable to thinning.

3.2.6 Temperature

To monitor internal stand temperature in mature cover patches and thinned second growth stands.

Internal stand temperature will be an important characteristic for use of a stand as thermal cover. Spacing will be the primary stand treatment considered here. Temperatures will be monitored in stands differing in age at thinning, age since thinning, and thinned stand density. Temperatures in mature cover patches may be monitored as controls.

3.3 Silviculture Effects on Animal Condition

To examine the influence of silvicultural activities on animal condition.

Silvicultural activities can be expected to influence the quality and quantity of available forage which in turn affects the condition of individual animals inhabiting the area.

Animal condition indices can be used to compare the relative vigor of individuals (and assumably populations) occuring in intensively managed and relatively unmanaged second growth forests.

3.4 Silviculture Effects on Population Status

To investigate the influences of second growth habitats and silvicultural treatments on elk population status.

Changes in habitat due to secondary succession and silvicultural treatments may have positive or negative impacts on elk populations. Positive impacts may result where increases in survival and/or productivity occur, while negative impacts may result with decreases in one or both of these parameters. Dispersal may also be important in determining population trends. Survival and productivity are influenced proximately by animal condition, and ultimately by habitat quality. Population condition can thus be used as an indicator of range quality or condition. The following are sub-objectives for population investigations.

3.4.1 Aerial Survey Feasibility Tests

To investigate the effects of silvicultural treatments and second growth habitats on population productivity and survival rates.

Indices of productivity and recruitment will indicate population trends. Herd composition counts from ground and air, conducted in late summer and late winter, will provide such indices. These may be supplemented by pregnancy rate estimates from hunter killed females.

3.4.2 Productivity

To investigate the feasibility of a mark-recapture experiment to estimate population size, changes in population size, and the rate of dispersal from herds in managed and unmanaged second growth forests.

3.5 Predation

To investigate the influence of predation on elk habitat utilization, condition and population status.

Potential predators include black bear, cougar, humans, and wolf. Legal harvest of elk is under a limited entry system and can be manipulated to satisfy specific objectives. The influence of wolves appears to have the greatest potential predator impact (refer to problem analysis), and will be the target species for most predation discussion in this working plan.

Predation may influence elk responses to silvicultural treatments, making it difficult to interpret certain changes on a habitat level. For example, wolf pack size may increase in response to elk population growth; such a response may negate positive elk population changes. It is possible that elk avoid certain habitat types in which vulnerability to wolf predation is increased; this may occur independently of other habitat considerations such as forage and cover. The following set of sub-objectives are proposed to assess the type and magnitude of wolf impacts on elk; a similar approach will be applied to bear and cougar populations.

3.5.1 Estimations of Wolf Density

To estimate relative wolf densities within study area.

Estimates of wolf density through track counts and incidental sightings will initially be employed to assess potential wolf impacts.

3.5.2 Food Habits of Wolves

To monitor wolf food habits within study areas.

Wolf food habits will indicate percent occurence of elk in the diet, and elucidate impacts suggested by relative wolf densities.

3.5.3 Movements and Habitat Use of Wolves

To determine movements and habitat utilization of wolves within managed and unmanaged second growth if high wolf densities are indicated.

Radio collaring and monitoring of wolf movements will be done if the two previous procedures indicate heavy predation on elk by wolves. Radio locations analyzed in conjunction with elk movements should indicate the degree to which elk habitat utilization is influenced by wolves.

3.6 Habitat Enhancement

To examine the feasibility of habitat enhancement as a means of increasing elk survival, population productivity, and individual animal condition, and decreasing animal damage.

The feasibility of increasing available forage for elk by various techniques can be assessed by satisfying the following sub-objectives.

3.6.1 Propagation

To investigate the long term costs and benefits of propagating forage species for elk.

The feasibility of extensive plantations of browse species for elk depends on the time and money involved in the establishment of plantations, and the resulting benefits including long-term survival of planted species, elk use of plantations, and the reduction in damage to nearby commercially valuable conifers.

3.6.2 Non-silvicultural Fertilization

To investigate the costs and benefits of non-silvicultural fertilization as a means of increasing forage quality and quantity on elk foraging areas.

Increases in forage nutrient content, forage utilization by elk and related costs, will determine the feasibility of non-silvicultural fertilization as a means of habitat enhancement.

3.6.3 Interplanting and Underplanting.

To examine the feasibility of interplanting and underplanting of forage species as a means of providing alternate browse for elk.

Monitoring plant survival and utilization of interplanted and underplanted stands under various planted or thinned stand densities will determine the feasibility of these methods of habitat enhancement. Monitoring growth and elk browsing intensity of conifers in underplanted, interplanted, and control plantations will determine the detrimental or positive influences of these techniques on competition and changes in the degree of conifer browsing.

3.6.4 High-site type conversion.

To examine the effects of high-site type conversion on elk untilization of an area.

Reclamation of high-site index land presently occupied by non-commercial tree species often involves cutting existing deciduous trees to open the canopy and increase survival of commercially valuable conifers. The result is often sprouting, which provides sources of forage from species such as willow (Salix spp.), black cottonwood (Populus trichocarpa) and maple (Acer spp.). The impacts of such browse rejuvenation which occurs as a by-product of site conversion practices will be assessed by monitoring the increase in available forage and subsequent utilization by elk.

4 METHODOLOGY

The following proposed methodologies are subject to alteration and refinement as the project proceeds. Field work for the current year (81/82) will be directed at animal movement and habitat utilization activities, and these methodologies receive greater detail. Estimates of sample size requirements for many activities will be dependent on analysis of preliminary data collected this year. In addition, a proposed Habitat Component of the IWIFR program will be initiated to investigate vegetation and climate responses to silvicultural practices. The habitat assessment section of the elk project will be concerned, in the short term, with a detailed cover type description of the study area, and will not undertake intensive monitoring of vegetation/climate response until the habitat program is operational and objectives, methodologies, study areas, etc. are known.

4.1 Habitat Utilization and Movements

Direct observation of marked individuals (Harper 1971; Craighead et al. 1972; Franklin et al. 1975; Severson et al. 1978; Shoesmith 1979,) and radio telemetry (Rongstad and Tester 1969; Alexander 1973b; Craighead et al. 1973; Moir 1976; Gladfelter 1978; Rodgers et al. 1978; Harestad 1979; Inglis et al. 1979) have been extensively used to determine home range and habitat utilization of large mammals. Radioactive materials, dyes for urine and feces, and photographic devices have also been used with varying degrees of success (Sanderson 1966).

Several methodologies have been examined for use in this proposal.

Direct observation is difficult if not impossible in thick cover and at night, and the problems of observer influence confound the situation. Therefore, radio telemetry will be used to determine habitat utilization by elk, with incidental sightings of both collared and uncollared animals used as supplementary information.

Initial reconnaissance by aircraft, examination of forest cover and treatment maps, and consultation with divisional foresters will allow selection of areas where collaring attempts will be concentrated, based on the presence of elk in the area and the amount of types of silvicultural activities being carried out.

Twenty neck-fitted radio collars are available for the first year of study. Under the assumption that calves remain with cows during their first year, calf movements will be assumed similar to those of mature cows with calves. Attempt will be made to radio collar cows, yearlings of both sexes, and mature bulls. Expandable radio collars or solar ear tag radio transmitters will be necessary for use on mature bulls.

4.1.1 Calibration of Equipment

Error polygons (Springer 1979) will be constructed from triangulation of a variable number of fixes (minimum of 3 on a known location transmitter) under numerous environmental conditions.

4.1.2 Capture and Immobilization

The large size of elk requires that immobilization of animals be carried out to fit radio collars and obtain blood samples. This will be accomplished by using an immobilizing drug in a Cap-chur gun and syringe dart system and will occur during late winter when animals are concentrated on the winter range.

Approach on foot to a distance close enough to be effective with a dart gun (50-150 ft.) has been successfully accomplished on a large number of elk in Yellowstone National Park (Craighead et al. 1973), 33 in Oregon (Schoen 1977) and 4 elk on Vancouver Island (Smith 1976; Janz, pers. comm.). This method is quite time consuming (Janz, pers. comm.), but will be attempted if conditions arise where animals can be stalked from the ground. Another possible method of immobilization would be to use a helicopter to herd animals near one or more individuals on the ground with immobilizing dart guns.

Darting animals from a helicopter is the preferred method of capture, but other methods (including trapping with corral or clover traps) will be attempted when suitable conditions arise.

Results from past studies employing immobilizing drugs and the recommended dosages for Roosevelt elk are presented in Tables 2 and 3 respectively. The large muscle masses of the shoulder and rump will be shot at to reduce induction time (Haigh et al. 1977).

With each immobilization, information will be collected on: induction time, recovery time, dosage, and sex, chest girth and shoulder height of the individual. In addition, a 20 - 30 ml. blood sample will be collected and a single upper canine extracted for subsequent sectioning and age determination. Animals will be ear-tagged and radio collared and then observed from a distance to ensure complete recovery. Antagonist (reversal) drugs will be employed to ensure a more rapid recovery.

4.1.3 Radio Tracking

Radio locations of animals will be obtained by triangulation of three or more radio fixes of strongest signal readings from hand held antennae. Topographic and forest cover type maps will be consulted to determine where successive bearings will be taken and the influences of topography and vegetation will be assessed. Ground fixes will mainly be used, taken from road intersections and other landmarks easily identifiable on forest cover maps or air photos. Position and bearing will be recorded for subsequent mapping. A subjective appraisal of precision of the location similar to that used by Harestad (1979) will be made.

Daily radio monitoring will be carried out to obtain locations for as many individuals as possible. All collared individuals will be located at least once every 3 days by ground. If by the third day, a particular individual

Table 2. Immobilizing drugs used on North American elk

Drugs	Dosage	Induction time	Period of Immobilization	Reference	Comments
Succinylcholine chloride	Jan. -9 mg Aug.-Sept 16-17 mg	6 min.	14-22 min.	Harper 1965	- respiratory assist. may be required. - condition of animal dictates required dosage.
Succinylcholine	calves (4-11 mos) 15-20 mg cows (-12 mo) 20-25 mg bulls (- 12 mo) 25-35 mg.	10.5 mins (range = 3-25 min)	46 mins. (range = 7-178 mins.)	Flook et al. 1962	- sex and age determines required dosage.
Succinylcholine	33-35 mg.	7-8 min. (range = 3-18 min)	13.4 mins. (3-45 min)	Alexander 1973	- used in conjunction with hyaluronidase - possibly using weakened solutions.
Succinylcholine	0.0345 mg/lb (range = 0.03-0.04)	7.2 min (range = 2-23 min)	10-27 mins	Davies In Hebert & McFetridge 1979	
Succinylcholine	0.086 mg/lb	10 mins.	1-2 hrs.	Baldwin & Williams 1971	- 2 of 4 animals immobilized died
Succinylcholine chloride	Yrlings: 15-18 mg Adults: 22-25 mg	5 - 15 mins.	20-29 mins.	Schlegel 1974	- 2-3 mg M99 used to maintain immobility reversed with M50-50 in 2 times dosage of M99.
Succinylcholine chloride	15 - 20 mg.	- -	- -	Janz unpubl.	- 2-3 mg M99 used to maintain immobility.
Succinylcholine chloride	bulls 12-14 mos. -26.03 mg. cows 12-14 mos. -22.33 mg. cows 2-10 yrs. -27.72 mg.	6 mins.	25 mins.	Pederson & Thomas 1975	- used powdered form of drug.
Succinylcholine chloride	1 mg/45 lbs.	- -	- -	Craighead et al. 1973	- animals were more sensitive during winter, less in spring and least in fall.
M99 (etorphine hydrochloride)	5 - 7 mg	4 - 11.4 mins.	10-80 mins.	Magonigle et al. 1977	- Rose to standing 1.4 - 16.7 mins. after injection of M50-50. - Acepromazine used also (5 - 10 mg)
M99	Yrling bull 1.7-4.5 mg/100 kg Yrling cow 1.9-4.5 mg/100 kg Adult cow 2.2-3.0 mg/100 kg	12.6 - 21 mins.	10 - 25 mins. (then given M50-50)	Coggins 1975	- Administered with the tranquilizer Vesperin to reduce excitement.
M99	0.008 mg/lb (range = 0.008-0.010)	29 mins. (range = 18-50)	- -	Barrett 1973 In Hebert & McFetridge 1979	- Administered with acepromazine in ratio of 10:1
M99	0.015 mg/lb	6 mins.	18 mins.	Lynch 1972 In Hebert & McFetridge 1979	- only 1 adult male immoblized. 6 mins. to recovery after injection of M50-50.
M99	0.011 mg/lb (range = 0.005 - 0.015)	3 - 10.5 mins.	1/2 - 6 mins.	Thorne 1974 In Hebert & McFetridge 1979	- used with acepromazine.
M99	.009 mg/lb	2.5 mins.	- -	Wolf & Stuart 1970 In Hebert and McFetridge 1979	- one captive female immobilized.
M99	0.009 - 0.010 mg/lb	- -	- -	Janz unpubl.	- ineffective.
M99 + Rompun	4 mg. M99; 60-85 mg. Rompun	- -	- -	Janz unpubl.	- ineffective.
Immobilon (2.45 mg. M99/CC)	0.017 - 0.023 mg/lb	- -	- -	Janz unpubl.	- effective.
Fentanyl & Rompun	Fentanyl: Females 0.07 mg/lb Males 0.09 mg/lb Rompun: 0.09 mg/lb	- -	- -	Haigh 1976	- Excellent immobilization

Table 3. Recommended dosages of immobilizing drugs for use on Roosevelt elk

Drug	Recommended Dosage	Reference	Comments
M99	0.011-0.015 mg/lb	Lynch 1972; Thorne 1974 In Hebert and McFetridge 1979.	M50-50 used for recovery administered in 2 times the dose of M99.
Immobilon (M99 + acepromazine)	0.017-0.023 mg/lb	Janz unpubl.	Effectively used on Roosevelt elk.
Fentanyl citrate Rompun.	female-0.07 mg/lb male-0.09 mg/lb	Haigh 1976	Used in conjunction with 0.09 mg/lb
Succinylcholine chloride	15-20 mg.	Janz unpubl.	2-3 mg. M99 used to maintain immobility; (reversed by M50-50)
Succinylcholine chloride	9 mg. in Jan. 16-17 mg. in Aug.-Sept	Harper 1965	Condition of animal (time of year) determines dosage.

cannot be located, a flight will be made over the entire area to locate the animal. During migratory periods, individuals of different areas, sex and age groups will be located a minimum of once daily in order to determine migratory routes and dates of departure and arrival on seasonal ranges. Direct observation will be used to gather supplementary data and to test the assumption that movements and habitat use of radio collared animals are representative of the population. Data recorded from observed animals will include activity, cover type use, adjacent cover types, response to observer, sex and age classification, etc, (Sec. 9).

Activity budgets will be estimated by recording signal response at each fix (active/steady). Instantaneous samples from the twenty collared animals will provide information on seasonal diurnal activity patterns, and general activity associated with cover type (Janz 1980b). More detailed information on time/activity budgets and activity/cover type relationships will require intensive monitoring of selected individuals for twenty-four hour cycles (i.e. ten minute periods at one hour intervals). Rustrack recorders can also be employed to automatically record activity patterns, although sample sizes are difficult to estimate. For example, Schoen (1977) used a Rustrack recorder to obtain 43 samples of 24 hour periods for nine individuals. Other than general active peaks at crepuscular periods, there was very little similarity in activity patterns between individuals or for the same individual between consecutive days. The grouped data was adequate for estimating percentage activity on a seasonal basis, stratified by crepuscular, diurnal, and nocturnal periods.

The use of telemetered heart rates for estimating energy expenditure is a relatively recent technology that may have application to our research. Proposed study of this technique by the forestry-wildlife group at the University of B.C. on blacktail deer will indicate the potential for use on elk. Recent studies on white-tailed deer indicate that further research is required on the heart rate - energy expenditure relationship, as only 36% of the variation in energy expenditure was accounted for by heart rate (Mautz and Fair 1980).

Fortran coding of location data will be carried out as the study proceeds to prevent an excessive backlog of office work.

4.1.4 Track Counts

Supplementary track counts in snow during aerial censuses will serve to identify presence or absence of elk, particularly in open habitat types.

4.1.5 Data Analysis

4.1.5.1 Home Range and Migration Data

Delineation of home range will be accomplished using Harestad's (1979) analysis of 100%, 90% and 50% home range using radio locations and the minimum area method (Mohr 1947). Analysis of variance will be used to test for significant differences in seasonal home range size; t-tests will be used to test for significant differences between mean centres of activity (arithmetic mean of location coordinates) to determine the migratory status of the animals and monitor utilization changes in response to treatment effects within the home range.

Migratory routes as determined by radio telemetry will be mapped and subsequently assessed by habitat type to evaluate the importance of corridors of specific habitat types.

4.1.5.2 Habitat Selection

Habitat selection can be determined by testing for statistically significant differences between use of various habitat types and the availability of those habitat types within the study area, using the standard chi-square technique (Marcum and Loftsgaarden 1980). Various multivariate procedures (multiple regression, factor and discriminant analyses, etc.) may provide further insight into the importance of various environmental attributes on habitat selection (Janz 1980a). Use of these analytical techniques will be explored at later data analysis stages.

4.2 Food Habits.

Three major methodologies for the analysis of food habits of free-ranging ungulates are available: rumen analysis, fecal analysis and direct observations of wild or captive animals. All three methodologies have limitations which must be considered in interpreting results (Mitchell et al. 1977). In rumen analysis, differential digestion of different species, the different rates of passage of food from the rumen, the short time period to which the sample relates (previous 48 hours), and the non-repeatability of samples (animals need to be killed) are the major interpretive limitations. In fecal analysis, the limitations include differential digestion of the cuticle in different species and different rates of passsage through the gut for different species. Direct observations do not allow quantitative estimates of different species eaten and are also logistically limited by the time involved in making adequate observations. However, direct field observation will provide supplemental information on feeding behavior, which may have important management implications (i.e. cratering, tree-lining, use of litterfall, etc.).

Proposed methodology:

The major methodology which will be employed for food habits studies will be fecal fragment analysis, due to the advantage of not requiring direct animal contact. Rumen analysis will be employed where rumen samples become available.

4.2.1 Fecal Fragment Analysis

This technique as described by Sparks and Malechek (1968) will be utilized for analyses of food habits . The use of this technique requires the compilation of a reference slide collection and preparation of fresh or frozen fecal samples. A plant voucher slide collection and key exists for many potential elk forage species (Janz in prep.). Prepared fecal samples are sub-sampled microscopically for frequency of occurrence and area coverage of plant species.

Regular collections of fresh fecal pellets will be made from specific herds chosen on the basis of habitat types and seasonal ranges utilized such that differences between habitat availability and diet may be assessed (chi-square). Pellets will be collected as a random sub-sample from a pellet group. Each sub-sample collected should be 1 or 2 handfuls so that enough material is available for both fecal fragment and fecal nitrogen analysis. Sample size for each herd for each month should consist of at least 8 sub-samples. Fresh fecal samples will be frozen in air-tight containers until analyzed.

4.2.2 Rumen Analysis

Specimens for rumen analysis will be collected from hunter kills and possibly selective kills. Analysis of samples will follow techniques as described by Puglisi et al. (1978).

4.3 Habitat Assessment

Assessment of available habitat types will be made for the following physical and biological attributes:

4.3.1 Physical Characteristics (RAB[1980] data sheet)

4.3.1.1 Slope - from an average of several clinometer readings.

4.3.1.2 Aspect - from hand held compass readings.

4.3.1.3 Elevation - from 1:50,000 topographic maps of the study area.

4.3.1.4 Soil Features - TSB 1:50,000 soils and landform maps.

4.3.1.5 Weather

Nine weather stations from ASB are available and will be established in stands representative of various silvicultural treatments for comparative purposes (various stages of canopy closure, stem density, age, etc.). Each station will consist of:

- Stevenson screen
- max. and min. thermometers
- thermograph
- rain gauge
- 5 snow stakes

In addition, ASB have a number of solarimeters that will be available during winter months. Measures of radiation reaching ground or bedding level will be collected from stands representing the structural effects of canopy closure and stem density and physical effects of aspect and slope.

4.3.1.6 Snow Depth and Density

Snow depth and density will be measured on a weekly basis (if logistically possible) during winter months at weather stations and other permanent vegetation plots. Depth will be assessed by taking an average of snow height on 5 permanently marked stakes at each plot. Density will be evaluated by averaging several weight to volume ratios of snow in the area, although specific methodologies may change pending results from the work on snow-ungulate interactions by the forestry-wildlife group at U.B.C.

Snow density will be related to elk mobility by determining snow hardness when the sinking depth or track depth can also be measured. It is essential to collect information on sinking depth and snow density shortly after the track has been made to avoid changes in either or both of these measurements due to weathering. Therefore, radio telemetry will be used to locate animals, and then immediate measurements (track depth and adjacent snow density) will be taken. It will be important to monitor animal locations immediately following periods of heavy snowfall to document use of thermal cover.

4.3.2 Biological Characteristics

4.3.2.1 General Vegetation Analysis

The first procedure required to describe the vegetative components of the study area will be the collection of recently published information. Forest cover maps, silvicultural treatment maps, air photos, and ecosystem unit maps (TSB, MOF) will be used to stratify the study area. First priority for stratification will be based on seral stage, especially stands exhibiting existing and proposed silvicultural practices, within a biogeoclimatic subzone or ecosystem unit.

The habitat assessment sampling design is similar to that of Nyberg (1980). The RAB (1980) format will be used for describing the cover types on permanently established 20 m square plots (dimensions may be modified to sample specific ecosystems such as riparian zones, wet meadows, etc.). Plots will be tentatively located on air photos, followed by a ground record to confirm that the location is representative of the stand. A total floristic list, percent cover (ocular estimate), distribution, and vigor will be collected by height strata (RAB 1980). Overhead canopy closure will be estimated by ocular estimate and an appropriate quantative method (densiometer, etc. - pending results of a test of 7 methods by the forestry-wildlife group at UBC [Bunnell, pers. comm.]).

4.3.2.2 Understory Woody Stems (20 cm - 2 m)

Four 1x20 m transects (20% of plot) will be established as illustrated in Figure 1. Stem counts, basal stem diameters, height, and percentage browse by species will be recorded. A "species-area curve" will be used as a check on sampling intensity; some plots may exhibit very sparse understory abundance and diversity, requiring less than 20% sampling, while others may indicate the need to establish another 20 m square plot. A tree species count ($\leq$ 10 cm dbh, $>$ 10 cm dbh) and average dbh by both strata will also be recorded.

4.3.2.3 Herbaceous Layer

Eight 1 m square mini-plots (2% sampling intensity) will be established within the plot as illustrated in Figure 1. Stem counts, height, diameter of 'clumps' (ferns), and percentage browse by species will be tallied. Stem counts of woody stems $<$ 20 cm in height will also be recorded. Additional herbaceous plots will be established if the species-area curve indicates the sampling intensity is inadequate in comparison to the floristic list (4.3.2.1).

4.3.2.4 Pellet-Group Survey.

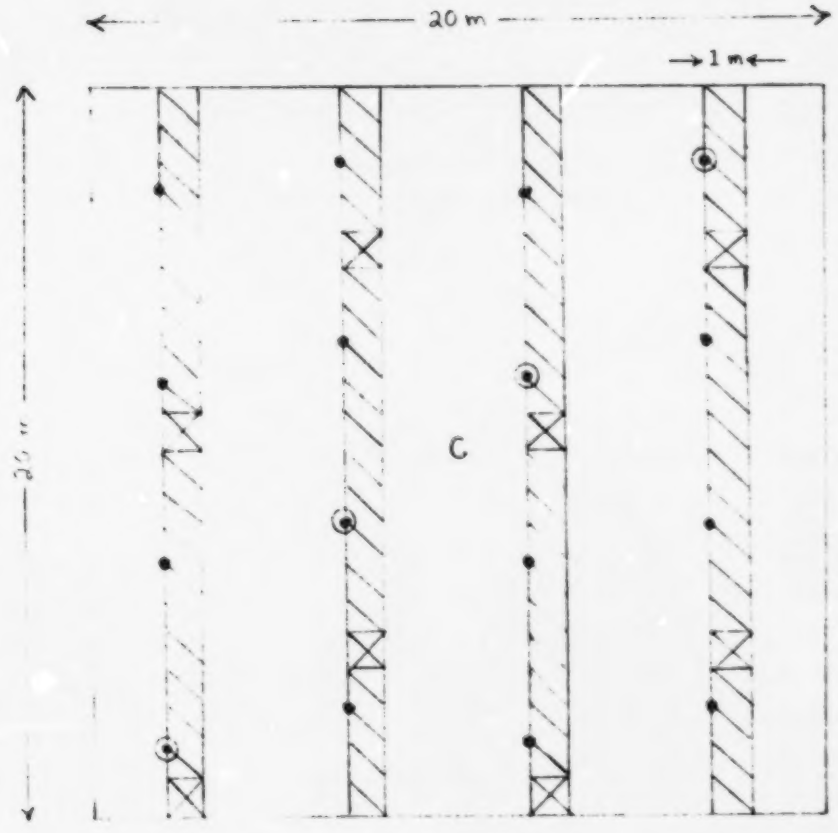
Selected plots (treatment vs. control or pre and post-treatment comparisons) will incorporate intensive sampling of animal use as indicated by pellet-group counts and browse production/utilization measurements (4.3.2.5). Sixteen 10 m^2 circular pellet-groups plots (40% sampling intensity) will be established as illustrated in Fig. 1. Initial work will entail counting and clearing all deer and elk pellet-groups. Subsequent counts and clearing will depend on specific objectives and logistics, but should be conducted at least semi-annually to obtain information on time of use.

4.3.2.5 Browse Production/Utilization

Four permanent sample centers will be established diagonally across the plot (Fig. 1). Key forage species (as determined by evidence of browsing and diet analyses) within 1 m of the sample center will be tagged (5 closest individuals); basal stem diameter, height, crown volume measurements, number and average diameter of annual twigs and number of browsed twigs and average browse diameter, by 50 cm height intervals, will be recorded for each specimen. Average browse diameter and browse intensity by height strata, combined with the pellet-group data, should indicate the species (deer or elk) utilizing the site.

4.3.2.6 Access/Debris

At each 1 m interval along the perimeter of the 20 m square plot, information on "accessibility" into the plot will be assessed. This will entail characteristics of ground cover (spacing debris, fallen logs, trail, water, understory development, etc.) and height measurement of features impeding movement.



understory woody stem transect (1 X 20m)

herb layer (1 X 1m)

• pellet group plot center (r = 1.8m = $10m^2$)

production/utilization center

C center with sighting board

Figure 1. Plot design for habitat assessment.

4.3.2.7 Visibility

A sighting board or tube, graduated in 50 cm height intervals to 2 m, will be located at the plot center, and percent visibility by height intervals will be estimated at 10 - 20 m intervals until total obscurity (or 200 m) along 4 transects running from plot center perpendicular to the plot boundaries. Restricted visibility due to topographic features will also be recorded. This information will be used to indicate suitability of the stand for providing escape or hiding cover.

4.3.2.8 Forage Quality Analysis

Analysis of the nutritional quality of selected forage species, as determined by diet analyses, will be conducted on a seasonal and habitat type basis. Clippings of current annual growth twigs will be collected from a number of randomly chosen individuals to be air-dried, ground, and sub-sampled for laboratory analysis of:

- nitrogen (N) (AOAC 1975)
- energy (bomb calorimetry - Robbins 1980)
- dry matter digestibility (DMD) (Tilley and Terry 1963)
- Ca, Mg (Christian and Feldman 1970; Perkin-Elmer Corp. 1973)
- phosphorus (P) (Jackson 1958)
- acid detergent fiber (ADF), neutral detergent fiber (NDF), and lignin content (Georing and Van Soest 1970).

4.3.2.9 Future Considerations

Additional habitat assessment activities will be reported in subsequent working plans, pending progress and results from the 81/82 field season, and coordination of activities with the habitat component of the research program. Possible activities include:

- clipping of forage species for biomass and productivity figures, and establishment of regressions for estimating these parameters from various predictor variables (stem diameter, height, crown volume, twig diameter - weight; (see Rutherford [1979] for review).
- exclosure plots to examine vegetation response to various silvicultural practices (or browsing pressure) by excluding ungulate use.
- plots to determine decomposition rates of thinning debris.

4.3.3 Analyses

Analysis of the habitat assessment data will include:

- site descriptions and floristic list summaries which will provide the basis for a detailed habitat type classification map of the selected study area (using FS and/or TSB computer programs).
- relationships between the more detailed understory measurements (i.e. density, height, stem diameter, etc.) and percent cover which will be analyzed (regression analysis) to explore the validity of using percent cover to estimate browse biomass. Comparisons of plant density, weather variables, and visibility between different habitat types will be made by analysis of variance and t-tests. Correlation and regression analysis will be used to determine the relationships of canopy closure on understory plant diversity and density, visibility, and snow characteristics. Pellet-group and browse intensity data will supplement habitat use data obtained by telemetry and provide comparisons of future treatment monitoring experiments. Correlation analysis will also be used to explore the relationships and linkage between:
  - available forage (habitat use) to food habits (4.2) (=diet selection)
  - diet selection to forage quality (4.3.2.8) (=diet quality)
  - diet quality to animal condition (4.4.3) (=habitat quality)
- all the environmental attributes (independent variables) which will be used to develop a model of habitat use/selection (dependent variable) as outlined in Section 4.1.5.2.

4.4 Animal Condition

4.4.1 Body Fat

Indices of total body fat reserves are the most widely reported measurements of body condition (Janz 1979). The kidney fat index (KFI) is computed by dividing the weight of the perinephric (perirenal) fat by the kidney weight and multiplying by 100 (Janz 1979).

The total kidney fat method which includes all perirenal fat is reportedly more sensitive to fat deposition than the Riney (1955) technique, which involves cutting the fat perpendicular to the long axis of the kidney in an attempt to standardize the measurement (Manson et al. 1974).

KFI has been used to indicate the relationship between body condition and pregnancy rates of adult female Roosevelt elk (Trainer 1971) and increased mortality of male Rocky Mountain elk greater than 7 years of age (Flook 1970). Variability as a result of age, sex, and season make values obtained from adult females most desirable for inter-herd comparisons (Caughley 1970; Anderson and Medin 1972).

Proposed methodology

Kidney fat index will be determined from the total fat method for hunter collected samples from animals killed in the study area. Samples will also be obtained from any animals collected for other reasons or from accidental fatalities during capture activities. Inter-herd comparisons will be made on the basis of samples collected from adult females. Problems associated with this index will be the limited number of samples and the difficulty in getting total kidney fat from hunter samples.

4.4.2 Blood Analysis

Serum non-esterified fatty acids (NEFA) increase with reduced digestible energy intake (Bowden 1971). Thus, NEFA is a potential indicator of energy balance. However, the effects of handling stress on this parameter must be considered when dealing with wild animals (Slee and Halliday 1968).

Blood urea nitrogen (BUN) has been reported by numerous investigators to illustrate trends in protein intake (Franzmann 1972; Seal et al. 1972; Skeen 1974; LeResche et al. 1974; Robbins et al. 1974; Hyvarinen et al. 1975; Kirpatric et al. 1975; Seal and Hoskinson 1978; Hebert 1978) and to be relatively insensitive to handling stress (Seal et al. 1972; LeResche et al. 1974; Karns and Crichton 1978). The major drawback to BUN analysis is that increases in BUN may indicate

high protein intake or very low protein intake associated with muscle catabolism. As with all blood parameters, establishment of normal values within boundary classes of age, sex, season, reproductive status, and handling methods are required before management-related interpretations can be applied (LeResche et al. 1974).

The use of blood parameters for assessing animal conditon will be restricted due to limited sample size collection, and therefore will only contribute supplemental information to fecal nitrogen values (4.4.3).

Proposed methodology:

a) Approx. 20-30 ml. blood samples will be collected from all immobilized animals and frozen for subsequent lab analysis of NEFA and BUN.

b) If sufficient time is available, baseline values should be obtained from captive Roosevelt elk (possibly at Vancouver Game Farm) from various sex and age classes and nutritional planes to assess the influence of immobilizing drugs and handling excitability on the values obtained in free-ranging animals.

4.4.3 Fecal Nitrogen

A strong relationship between seasonal changes in fecal crude protein and rates of weight gain have been reported for Rocky Mountain elk (Gates 1979) with weight stasis occurring at protein levels of about 10%. Jorgenson and Wishart (1979) have found a significant relationship ($r = -.97$; $p < .05$) between fecal crude protein values during May - June and early lamb mortality in bighorn sheep over 4 years of study. Neonatal mortality has been negligible at protein levels of 23+%, while a 33% mortality was related to protein levels of 17%. Current investigations are using fecal protein levels to monitor the nutritional status of Vancouver Island elk (Janz, in prep.; refer to problem analysis).

When combined with BUN, fecal N values can be used to indicate whether an animal is above or below protein maintenance levels (Hebert 1978). The simplicity of collecting fecal samples and determining nitrogen content through Kjeldahl analysis (AOAC 1975) makes this technique especially attractive for assessing the condition of free ranging ungulate populations.

Proposed methodology:

a) Fecal pellets will be collected, concurrent with fecal collections for food habits analyses, on a monthly and habitat type basis. Only fresh samples will be collected to establish temporal estimates of animal condition. Locating herds containing radio collared individuals will allow collection of fresh pellet groups.

b) A fecal sub-sample will be randomly selected, and after drying and grinding, subjected to nitrogen content analysis using macro-Kjeldahl techniques (AOAC 1975). Percent crude protein (CP) will be calculated assuming an average nitrogen content of 16% for protein, and no nitrogen sources other than protein in the fecal sample (CP = 6.25 x %N, Robbins [1980]).

4.5 Populations Measures

Population information is of importance in understanding population dynamics and assessing long term population responses to habitat change and other potential influences. Numerous approaches to measuring population performance are available (Mitchell et al. 1977) and these are outlined in Table 4. Each methodology has certain levels of cost and information attached to it. The primary objective of the present research project is to investigate elk use and response to intensively managed forests, not document elk population dynamics per se. For this reason the following methodologies are proposed:

a) sample classified counts (ground, air) to estimate seasonal herd composition (calves: yearlings: adults).

Table 4. Approaches available for measuring population performance

Population Assessment Procedure	Information	Relative Cost
Aerial counting	estimates of numbers; classification and distribution	variable (dependent upon desired accuracy) low - high
Ground counting	relative estimates of numbers; classification and distribution; difficult over large land areas or in dense vegetation	moderate - high
Mark - recapture	estimates of numbers; requires large (50% or greater) sample size; non-viable for large mammals except when used in conjunction with aerial surveys	high
Mark saturation	estimates of numbers; feasibility unknown	moderate
Mortality data	estimates of numbers and age structure; however, high percentage non-biased removal is required.	low
Sign counts (i.e. feces, tracks, etc.)	distribution and relative density estimates	low

b) a mark-recapture experiment, utilizing colour coded ear tags on radio-collared animals and a cooperative observer recording system with B.C. Ministry of Forests (MOF) and MacMillan Bloedel (MB) employees (40 - 50 observers [vehicles], to estimate population size, changes in population size, and dispersal rates.

c) collection of predator scats within the study area in order to assess predator abundance, distribution, and food habits on a preliminary basis.

4.5.1 Sample Classified Counts

Classification counts with adequate sample sizes, can provide population age structure data which can be interpreted to yield indices of productivity and recruitment.

Classification will be conducted from the ground on an annual basis when groups or individuals are sighted (during radio location or travel). Animals will be classified into one of four categories:

(1) calves
(2) yearling bulls (spikes)
(3) adult bulls (incl. antler conformation)
(4) cows (yearlings and adults)

Areas may later be stratified on the basis of radio telemetry home range information such that data on separate herds can be distinguished.

Classification will also be conducted from the air (helicopter) during two periods of the year, late winter and late summer, in order to supplement ground counts in assessing recruitment and productivity, respectively. Aerial counts will consist of 1 - 3 hour flights in which the study area, or a selected portion of the study area, is covered. Group sizes will also be recorded. Sample sizes will be dependent upon results of mark-recapture experiments and population size estimates.

Possible relationships between animal condition values (4.4) and population productivity will be explored by regression analysis (Jorgenson and Wishart 1979).

4.5.2 Mark-recapture Experiment

Elk captured for radio collaring will also be given colour coded ear tags so that individuals may be recognized on the basis of these tags alone. Individual recognition of marked elk, independent of radio telemetry, will enable a mark-recapture experiment tc be carried out following the Jolly-Seber method (Seber 1973). In this method, a series of samples of varying sizes are made over an extended period and each sample captured is examined for marked members. In this way a capture-recapture history of individual animals is compiled. A stochastic analysis of these capture-recapture histories (see Caughley 1977:148) allows estimation of the parameters of an open population in which there is death, recruitment, immigration and emigration. Radio telemetry information will assist in defining population (or herd) boundaries.

In order to perform this experiment, both a marking and a recapture system are required. In the first year of study, marking will be done in conjunction with radio collaring activities. In future years more intensive marking may be done utilizing baited corral and/or clover traps set when there is snow on the ground, usually in late winter. Marking will be done with highly visible nylon collars and colour coded ear tags. It is necessary that the recapture system function independently of radio telemetry in order to avoid radio collar biases. For this reason, a cooperative observer recording system will be established with MOF and MB employees utilizing the study area. Sightings in which collared vs. uncollared animals are distinguished will be recorded in sighting form books placed in cooperating vehicles (approx. 40 - 50).

4.6 Predation

Predation on elk by wolves, cougars and bears has the potential to be a major influence on elk population status. In order to assess the potential impacts of these predators it is necessary to estimate species density and food habits within the study area.

4.6.1 Density

Predator density estimate methodologies which require the least number of man hours to conduct will be considered initially. Winter track counts and scat locations will be the primary methodologies used to assess predator distribution within the study area. Track counts will be conducted when snow conditions permit, while scat locations will be plotted on a map of the study area whenever collections are made. Scat densities (scats/km of road) and number of tracks counted per area may give estimates of relative predator densities. If a relatively high density of a predator species is indicated within the study area, more intensive study methods such as radio collaring will be considered in future years.

4.6.2 Predator Food Habits

Predator food habits will be assessed through scat collections made during routine road use and analyzed on the basis of microscopic hair identification. Mapping of scat locations will allow for the separation of predator food habits on the basis of elk distribution in space and time.

4.7 Habitat Enhancement

Enhancement of the required components of elk habitat in regenerating forests can be accomplished through direct enhancement efforts (forage production; non-silvicultural fertilization) or modifications in silvicultural practices. Both avenues of enhancement should be examined with forage quality and quantity, and elk response (determined by site utilization [radio telemetry]) as indicators of the suitability of the altered habitat. Enhancement activities are a low priority within the research program at present; specific projects will be conducted on an opportunistic basis.

4.7.1 Propagation

Supplemental feeding programs, particularly during winter, have been practised in an effort to sustain elk through winter conditions. However, the possibility of providing sustained forage through propagation of perennial species, particularly in regenerating forests, has not been investigated in coastal forest ecosystems.

In order to successfully propagate alternate forage for elk, plants should be chosen that are not only preferred browse species, but are also easily propagated and do not seriously compete with conifer regeneration. Salix spp. and Sambucus spp. have been indicated (pers. comm.)[1] to be heavily utilized by Vancouver Island elk during winter months.

Proposed methodology:

a) Experimental plantations of Salix and Sambucus have already been established at Elk River and Shaw Creek, respectively. Plant survival in these locations will be monitored to indicate the feasibility of establishing more extensive plantations using the site type and propagation methods utilized in these areas.

b) Additional experimental plantations will be established using a variety of site types and methodologies. Recording environmental conditions such as drainage, elevation, slope, aspect, and soil type will indicate under which circumstances survival may be increased. Table 5 is a summary of the methods by which Salix, Sambucus, and Populus (a potential browse species) may be successfully propagated. Exact techniques of each of these methods are well documented in the literature.

c) Experimental plantations should be established adjacent to areas recently replanted with conifers. Monitoring browse intensity prior and subsequent to the forage plantations' establishment will allow quantification of changes in the amount of browse on commercially valuable conifer stands with the introduction of adjacent alternate forage. Interplanting of forage species (simultaneous with replanting of conifers) and underplanting in thinned stands of differing density, should also be undertaken, monitoring resulting survival and associated costs.

[1] Personal file available from D. Janz, Ministry of Environment, Campbell River, B.C.

Table 5. Summary of available methods for the propagation of *Salix*, *Sambucus* and *Populus*

Species	Technique	Reference
Salix spp. (willow)	Softwood Cuttings	Tobey 1975
	Hardwood Cuttings	Oldale & Oldale 1975
	Seeds	
Sambucus spp. (elderberry)	Softwood Cuttings	Tobey 1975
	Division	Hartmann & Kester 1968
	Root Cuttings	
	Ripe Hardy Cuttings	Oldale & Oldale 1975
Populus spp. (cottonwood)	Softwood Cuttings	Tobey 1975
	Hardwood Cuttings	
	Root Cuttings	
	Grafting	

4.7.2 Non-silvicultural Fertilization

The application of fertilizers specifically to enhance forage quality in regenerating forests has not been documented. Experimental exclosures will be established in sites varying in environmental conditions (aspect, elevation, slope, soil type) and age of stand. Since forage quality and quantity is presumably most critical in the winter, known wintering areas will be examined first. Manual application of different fertilizers in different application densities will be carried out in the spring or fall of the year. Monitoring of elk forage species quantity (RAB format), vegetation clipping (during fall, mid-winter, and spring) for subsequent nutrient analysis (for protein, energy and mineral content), and semi-annual measurements of twig length and diameter of selected key browse species (for productivity estimates) in treated and adjacent control areas will determine the short and long term impacts of non-silvicultural fertilization.

4.7.3 Site Type Conversion

Reclamation of understocked areas of high potential productivity has become increasingly common in Vancouver Island regenerating forests. The impacts of these practices on elk will be assessed by determining forage quality and quantity, and elk utilization (from radio telemetry data) of areas differing in environmental conditions prior and subsequent to conversion activities.

4.8 Transplants

Transplants may be utilized in order to test habitat utilization of particular treated stands in areas where elk do not presently exist. If transplants do become necessary these procedures will be followed:

4.8.1 Selection of Transplant Herd and Transplant Site

Selection of a transplant herd and transplant site will be dependent on a number of criteria including the number of animals present, the logistics of capture and release, the influence of the transplant on other study herds, and the forestry activities present within the transplant site. Specific decisions about these criteria will be situation dependent and, therefore, are presently not defined. Several candidate transplant herds are presently known (Janz, pers. comm.).

4.8.2 Capture

Capture techniques need to be adaptive to particular sets of field conditions. Techniques to choose from include baited corral traps, baited clover traps, or helicopter drives into corral traps. The one transplant that has been done on Vancouver Island utilized baited corral traps. Squeeze chutes will be employed to mark or radio collar animals and obtain blood samples.

4.8.3 Transport

Captured animals will be transferred to the release site in a cattle transport truck.

5 STUDY AREAS

The relatively short time-horizon of the IWIFR program, in addition to the limited availability and logistics associated with collecting baseline information in an unlogged watershed, dictate that the majority of research be conducted in areas of second growth that offer a mix of unmanaged stands, past silvicultural treatments, and opportunity for future habitat manipulation once present habitat utilization is documented. The areas outlined below offer potential for investigating various components of the proposed research. Various management activities of the Fish and Wildlife Branch (FW) (Region 1) are in progress on many of these areas and may supplement some of the IWIFR research (Table 6).

5.1 Salmon River

The Salmon River watershed is under 2 major forest tenures - the Sayward Provincial Forest (SPF) and tree farm licence (TFL). A large portion (65%) of the SPF contains immature forest stands, which over the past 5 years have received intensive silvicultural treatment, consisting of juvenile and back-log spacing and fertilization (Ministry of Forests 1980). Some untreated stands and stands proposed for near-future treatment (spacing and thinning) exist that offer opportunity for monitoring animal and plant response.

Table 6. Study area - activity matrix of IWIFR and F & W involvement

ACTIVITY	Sayward Forest	T.F.L. 7	Mt. Washington	Nanaimo River/ Lakes	Shaw Creek	Elk River	Adam River	Trent River	Alternate Trans-plant sites	
Radio collaring	X	X	*	(*)	*			(*)	(X)	(*)
Habitat utilization	X	X	(*)		(*)	(*)	*	(*)	(X)	(*)
Habitat assessment	X	X			*	*	*	(*)		(*)
Survey/composition counts	X *	X *	(*)	*	*	*	*			
Fecal Nitrogen	X	X		(*)	(*)	(*)	*			
Weather monitoring	X	X					(*)			
Predators - density/ food habits	X	X					*			
Transplants			*					(*)	(X)	(*)
Marking	(X)	(X)		(*)						
Habitat enhancement	(X)	(X)			*	*	*			

IWIFR: X

F & W: *

Adjacent to the SPF are several stands of second growth forest within TFL 7 (Menzies Bay Division of MacMillan Bloedel Ltd.). This division is largely untreated silviculturally, only 200 - 300 ha have been juvenile spaced over the last 5 years (M. Broren [Div. For.], pers. comm.), and therefore offers the opportunity to gather baseline information regarding elk utilization of largely unmanaged regenerating forests. M. Broren (pers. comm.) intimated that no further spacing activities will be conducted in this area until the long term effects of this practise on tree production are better known. A small amount of commercial thinning is planned for the area in one or two years which will allow the collection of habitat utilization information prior and subsequent to this treatment. As viable elk populations exist in the Salmon River watershed, many of the research topics discussed in this working plan will be conducted, at least initially, in this study area.

5.2 Mt. Washington/Constitution Hill

In March 1979, a group of 13 elk were released near Constitution Hill in the Mt. Washington area west of Courtenay. Several individuals were radio collared and their movements followed, but the collars no longer function. Most of the area utilized by the elk is managed by the Courtenay Division of Crown Zellerbach Ltd.

The transplanted herd offers an excellent opportunity to examine habitat utilization in intensively managed second growth forests without the effects of traditional movement behavior. However, recapture of the transplanted animals will be necessary in order to attach new radio collars which will allow monitoring of movements and habitat utilization. Population status should also be monitored to determine if this group is expanding in numbers to occupy this habitat previously unexploited by elk.

5.3 Nanaimo River/Lakes

The Nanaimo River/Lakes area sustains a substantial number of elk. However, it is unknown if animals in these two areas are indepenoent groups, or if they are actually the same, highly mobile, herd. Therefore, an effort should be made to determine the degree of movement, or herd interchange, between these areas. Depending on the available manpower (local sportsman groups may provide volunteer assistance) several individuals should be radio collared in both areas and their movements monitored or, if conditions permit, as many animals as possible should be trapped and marked with neckbands. Future sightings of animals with individually recognizable neckbands would serve to document the degree of dispersal and herd interchange that occurs. These watersheds consist almost entirely of immature forest.

5.4 Shaw Creek

The west fork of the Shaw Creek Valley is privately owned by British Columbia Forest Products (BCFP). BCFP has extensive, high site type conversion activities planned for the next 5 years involving mechanical (scarification) and chemical (hack and squirt) techniques to remove competitive non-commercial tree species (mostly Alnus and Acer) and increase survival of commercially valuable conifers. The company also has 4 radio collars and a corral trap available for use in the winter-spring of 1981. Therefore an ideal situation exists for monitoring pre and post treatment utilization of converted lands.

Preliminary experimental propagation plots of elderberry (Sambucus) have already been established in the Shaw Creek Valley. Monitoring survival and elk use of these plots will determine the feasibility of attempting more extensive propagation endeavours using the techniques and site types chosen.

5.5 Elk River

In the fall of 1979, control of alder (Alnus rubra) by harvesting and by chemical treatment (hack and squirt) was undertaken by Fish and Wildlife staff in 2 study plots in the Elk River Valley. Populus sp. and Salix sp. were experimentally propagated in the chemically treated plot. Periodic monitoring of survival and elk use of the propagated plants, as well as elk use of the cleared plot, will provide information on the feasibility of more extensive habitat enhancement programs using these techniques.

5.6 Adam River

The Adam River watershed is a mature forest - early regeneration ecosystem in which elk habitat utilization and movements are currently under study (Janz, in prep.). This is the only quantitative ecological research of Vancouver Island Roosevelt elk conducted to date, but the applicability of the results as a baseline situation for comparison with elk in second growth forests is unclear, and therefore direct comparisons cannot be made.

5.7 Trent River

Permission has been obtained from most land managers in the Trent River watershed by Fish and Wildlife personnel for the transplant of elk into the area. The region consists mostly of second growth forests and land tenure is divided among numerous forest companies and private owners. A major land holder in the area is Crown Zellerbach Ltd., who have recently begun extensive thinning activities in the area (H. Langin, pers. comm.). Radio collaring and monitoring of transplanted animals will provide supplementary information on habitat utilization by elk in intensively managed second growth forests.

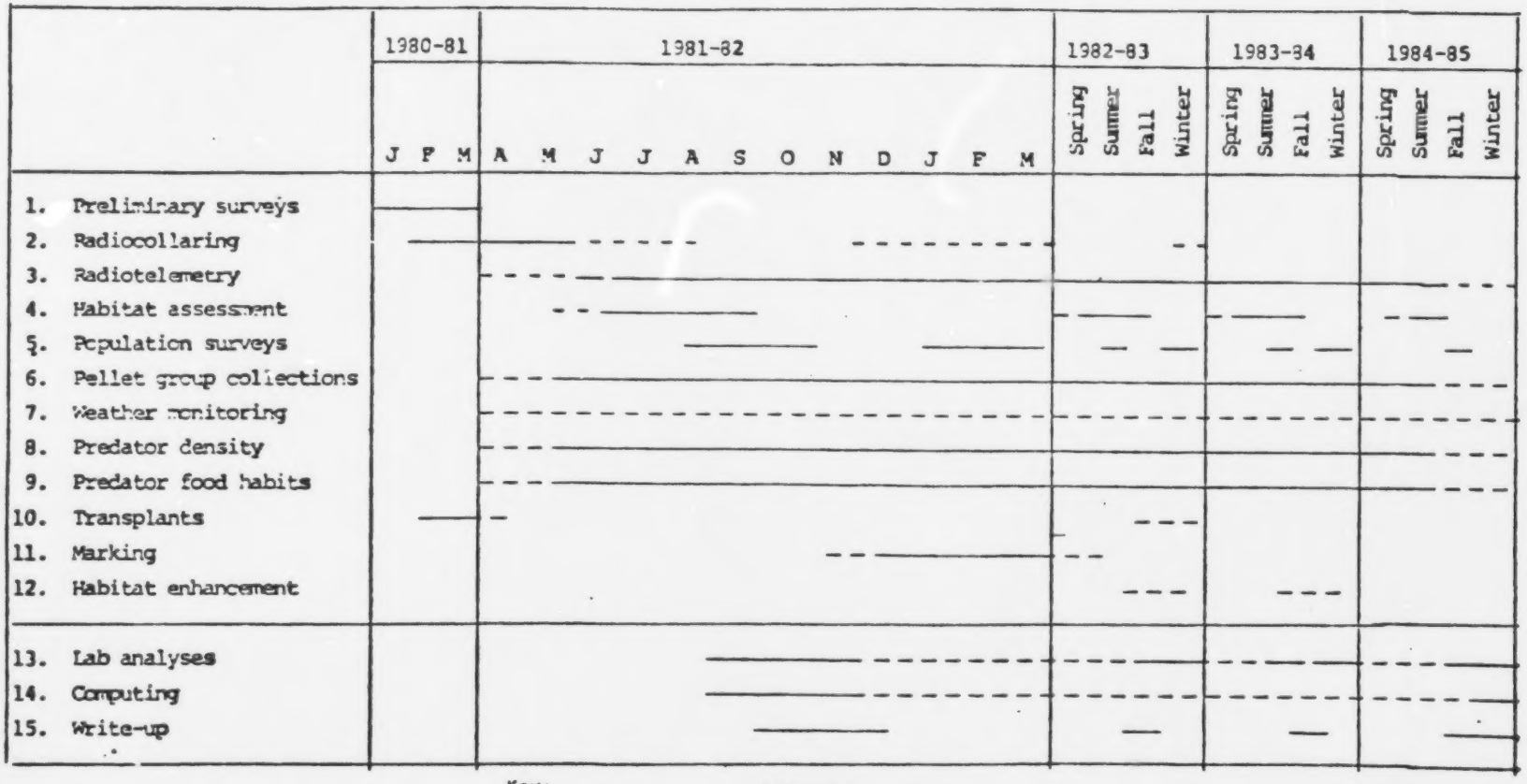
5.8 Alternate Transplant Sites

It may be necessary to conduct transplants of elk in order to test habitat utilization of certain treated stands in areas where elk do not presently exist.

6 SCHEDULING

The first full year of field work will be 1981-1982. Radio monitoring of collared elk will be the major time consuming activity. Other activities will include aerial composition counts, vegetation sampling, weather monitoring, pellet sampling, predator and elk track counts and possibly some marking. The timing of these activities is summarized on a monthly basis in the activity schedule (Table 7) presented below. Schedules for the years after 1981-82 will follow a similar pattern, although in the final year (1984-85) more time will be devoted to analysis and write-up.

Table 7. Tentative activity schedule



Habitat enhancement feasibility tests, not indicated in the activity schedule summary, will be a low priority in the first 1 - 2 years of study. These tests will be carried out if manpower can be made available (i.e. cooperation with wildlife or forest agencies).

7 COSTS

Table 8 is an estimate of the 81/82 budget by cost code and activity. Annual budget submissions will be included in future annual working plans. The 2 auxiliary positions (04) in this years budget represent the proportion of the habitat component allotted to the elk project. These positions may be transferred to the habitat component when this program becomes operational.

Table 8. Budget (IWIFR-ELK) 1981-1982

Code	Description	Total ($)	Effort by Activity (Man Months MM): Telemetry	Inventory Classified counts	Habitat Assess.	Food Habits Fecal N (condition)	Weather	Predation
01	2 Bio 1/1 4 mos.@ 1598 8 mos.@ 1726	24MM-40,416	19	1	1	1	1	1
04	1 Bio 1/1 (8 mos) 1 FWA 1/1 (4 mos)	12MM-20,340	1	.5	9		.5	1
10(01)	Travel-gas-450/mo x 12 expenses-150/mo	7,200	x	x	x	x	x	x
10(04)	Rental- 750/mo x 4 (assuming FS vehicle avail. sept - dec.)	3,000	x	x	x		x	x
20	Services:-							
	Blood: 65¢/sample x 20+	1500				x		
	Diet: 4 seas. x 5 herds x $150/sample	3000				x		
	FN: 12 mos. x 5 herds x 8/collection x $5	2400				x		
	Forage quality: 4 seas. x 3 cover types x = 10 spp. x $30/spp.	3600			x	x		
	Computer Services	2000	x					
30	Office - paper,xerox,etc.	500	x	x	x			x
60	Rental:	25,000						
	FW = 3 hrs x 26 wks x 130/hr	10,150	x					
	HC - 16 hrs @ 350+/hr			x				
	- 14 hrs	14,850		x				
	- 10 hrs - recollar		x					
75	Equipment	4,100						
	Collars-10x$250 (replc.)	2,500	x					
	Drugs-Fentanyl & M50-50	750	x					
	Capture-darts,tags,etc.	250	x					
	Misc-snowshoes, skiis, etc.	600	x				x	
	TOTAL	113,056						

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9 APPENDIX

Recording forms for data collection (Fig. 2-6) have been prepared for the following:

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9.1 AERIAL CENSUS FORM

DATE (yr/mo/day)_____ TIME START_____ TIME STOP_____ FLIGHT TIME____(mins

AIRCRAFT_____ PILOT_____ OBSERVER_____ POSITION_____

Weather:	1	2	3	4	5	6
Temp(code)						
Cloud(code)						
Wind(mph)						
Precip(code)						
Snow cover(code)						

Location	Time	Weather	Habitat (code)	Mature Bulls	Spikes	Other Yearlings	Cows	Calves	W/C Males	W/C	Total	Comments

AERIAL CENSUS FORM

CODES

Temperature(^{o}C):
1 = -15 to -10
2 = - 9 to - 5
3 = - 4 to 0
4 = 1 - 5
5 = 6 - 10
6 = 11 - 15
7 = 16 - 20
8 = 21 - 25
9 = 26 +

Precipitation:
1 = no precip.
2 = light rain
3 = heavy rain
4 = light snow
5 = heavy snow
6 = hail/sleet

Cloud cover:
1 = clear sky
2 = scattered overcast (<25% cover)
3 = broken overcast (25% < cover < 75%)
4 = few breaks in overcast (75% < cover < 100%)
5 = light overcast
6 = heavy overcast
7 = fog
8 = smoke

Snow cover:
1 = no snow
2 = trace
3 = 1" - 4" snow cover
4 = 5" - 12" snow cover
5 = 13" - 24" snow cover
6 = 25" - 36" snow cover
7 = >36" snow cover
8 = 1" - 6" patchy
9 = >6" patchy

Habitat:
1 = road
2 = recent clearcut (0 - 3 yrs.)
3 = recent clearcut (4 - 10 yrs.)
4 = recent clearcut (11 - 20 yrs.)
5 = regenerating conifers 21 + yrs.
6 = mature conifer
7 = deciduous
8 = mixed conifer/deciduous
9 = riparian
10 = river/lake flats
11 = meadow/bog
12 = slide
13 = right of way
14 = cultivated field
15 = residual/advanced regen pockets
16 = Other (specify in comments)

COMMENTS: _____

AERIAL CENSUS FORTRAN DATA CODE

DATA	COLUMNS	COMMENTS
(1) DATE	1-6	YR/MO/DAY
(2) FLIGHT TIME	7-9	Total flight time in minutes
(3) AIRCRAFT TYPE	10	1 = helicopter; 2 = fixed wing.
(4) TEMPERATURE ('C)	11	0 = no data 1 = -15+ to -10 2 = -9 to -5 3 = -4 to 0 4 = 1 to 5 5 = 6 to 10 6 = 11 to 15 7 = 16 to 20 8 = 21 to 25 9 = 26+
(5) CLOUD COVER	12	0 = no data 1 = clear sky 2 = scattered overcast (< 25% cover) 3 = broken overcast (25% < cover < 75%) 4 = few breaks in overcast (75% < cover < 1 5 = light overcast 6 = heavy overcast 7 = fog 8 = smoke
(6) WIND	13-14	In m.p.h.; 99 = no data.
(7) PRECIPITATION	15	0 = no data 1 = no precipitation 2 = light rain 3 = heavy rain 4 = light snow 5 = heavy snow 6 = hail/sleet
(8) SNOW COVER	16	0 = no data 1 = no snow 2 = trace 3 = 1"-4" snow 4 = 5"=12" snow 5 = 13"-24" snow 6 = 25"-36" snow 7 = >36" snow 8 = 1"-6" patchy 9 = 7"-24" patchy
(9) GROUP NUMBER	17-18	
(10) LOCATION	19-27	19-21 = Map Sheet (L=1; K=2) 22-24 = horizontal 25-27 = vertical

(Cont'd)

DATA	COLUMNS	COMMENTS
(11) HABITAT TYPE	28-29	00 = no data 01 = road 02 = recent clearcut (0-3 yrs) 03 = recent clearcut (4-10 yrs) 04 = recent clearcut (11-20 yrs) 05 = regenerating conifers (21+ yrs) 06 = mature conifers 07 = deciduous 08 = mixed conifer/deciduous 09 = riparian 10 = river/lake flats 11 = meadow/bog 12 = slide 13 = right of way 14 = cultivated field 15 = residual/advanced regen. pockets 16 = other
(12) HERD CLASSIFICATION	30-43	30-31 - mature bulls 32-33 - spikes 34-35 - other yrlings. 36-37 - cows 38-39 - calves 40-41 - unclassified adults 42-43 - unclassified
(13) FLIGHT TOTAL CLASSIFICATION	44-57	44-45 - mature bulls 46-47 - spikes 48-49 - other yrlings. 50-51 - cows 52-53 - calves 54-55 - unclassified adults 56-57 - unclassified
(14) FLIGHT TOTAL	58-60	Total # of animals for entire flight

9.2 ELK SIGHTING FORM

DATE: _____ TIME: _____ OBSERVER(S): _____

LOCATION: _____

_____"

MAP SHEET # _____

STAND # _____

SIGHTING # _____

WEATHER: TEMP. (code)____

CLOUD (")_____

WIND (mph)_____

PRECIP. (code)_____

SNOW (") _____

HABITAT TYPE (code) _____

DISTANCE TO FIRST EDGE _____ yds

FIRST EDGE HABITAT TYPE_____

DISTANCE TO SECOND EDGE _____ yds

SECOND EDGE HABITAT TYPE_____

	NUMBER	ACTIVITY (code)	COMMENTS
MATURE BULLS			
SPIKES			
OTHER YRLINGS			
COWS			
CALVES			
U/C ADULTS			
U/C			
TOTAL			

COMMENTS: Observation period - total time - by activity

- by cover type

Observation distance - flight distance - flight response into cover, etc.

ELK SIGHTING FORTRAN DATA CODE

DATA	COLUMNS	COMMENTS
(1) DATE	1-6	YR/MO/DAY
(2) TIME	7-10	2400 hr. system
(3) LOCATION	11-19	11-13 map sheet (L=1, K=2) 14-16 horizontal 17-18 vertical
(4) TEMPERATURE	20	0=no data 1=-15+ to -10 2=-9 to -5 3=-4 to 0 4= 1 to 5 5=6 to 10 6=11 to 15 7=16 to 20 8=21 to 25 9=26+
(5) CLOUD COVER	21	0=no data 1=clear sky 2=scattered overcast (< 25% cover) 3=broken overcast (25% < cover < 75% cover) 4=few breaks in overcast (75% < cover < 100%) 5=light overcast 6=heavy overcast 7=fog 8=smoke
(6) WIND	22-23	in mph; 99=no data
(7) PRECIPITATION	24	0=no data 1=no precip. 2=light rain 3=heavy rain 4=light snow 5=heavy snow 6=hail/sleet
(8) SNOW COVER	25	0=no data 1=no snow 2=trace 3=1"-4" snow 4=5"-12" snow 5=13"-24" snow 6=25"-36" snow 7=>36" snow 8=1"-6" patchy 9=7"-24" patchy

(Cont'd)

DATA	COLUMNS	COMMENTS
(9) HABITAT TYPE	26-27	00=no data 01=road 02=recent clearcut (0-3 yrs) 03=recent clearcut (4-10 yrs) 04=recent clearcut (11-20 yrs) 05=regenerating conifers (21+ yrs 06=mature conifers 07=deciduous 08=mixed conifer/deciduous 09=riparian 10=river/lake flats 11=meadow/bog 12=slide 13=right of way 14=cultivated field 15=residual/advanced regen pocke 16=other
(10) DISTANCE TO NEAREST EDGE	28-31	In yards (9999 = no data)
(11) HABITAT TYPE OF NEAREST EDGE	32-33	See habitat codes above
(12) DISTANCE TO SECOND EDGE	34-37	In yards (9999 = no data
(13) HABITAT TYPE OF SECOND EDGE	38-39	See habitat type codes above
(14) CLASSIFICATION AND ACTIVITY		Activity 00=no data 01=crossed road 02=standing watching observer 03=took flight b/c of observer 04=standing resting 05=milling around 06=bedded resting 07=bedded ruminating 08=feeding 09=travelling 10=fighting insects 11=nursing 12=seeking shelter 13=playing 14=aggression 15=fled from unknown causes 16=gradually moved out of sigh

(Cont'd)

DATA	COLUMNS	COMMENTS
	40-41	# of mature bulls
	42-43	Activity
	44-45	# of spikes
	46-47	Activity (see above)
	48-49	# of other yrlings
	50-51	Activity (see above)
	52-53	# of cows
	54-55	Activity (see above)
	56-57	# of calves
	58-59	Activity (see above)
	60-61	# of U/C adults
	62-63	Activity (see above)
	64-65	# of U/C
	66-67	Activity (see above)
(15) TOTAL # OF ANIMALS OBSERVED	68-69	

9.3 ELK IMMOBILIZATION REPORT

DATE: _____ INVESTIGATORS: _____

LOCATION: _____

WEATHER: Temp. (code) _____ HABITAT TYPE (Code) _____

Cloud (code) _____ SEX _____

Wind (mph) _____ AGE ESTIMATE _____

Precip. (code) _____ TOOTH EXTRACTED: YES/NO # _____

Snow cover (code) _____

IMMOBILIZATION DATA

DRUG	DOSAGE (mg.)	DOSE mg/lb	TIME ADMINISTERED	INDUCTION	RECOVERY	SITE OF INJECTION
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

EFFECTS OF DRUG

Respiratory (rate and depth) _____

_____

Reflexes: Muscle Relaxation _____

Muscle Tremor _____

Other: Sweating _____ Salivation _____

Pupil Dilation _____ Other Comments _____

Vomiting _____ _____

ANIMAL CHARACTERISTICS

Condition _____

Pelage _____

Chest Girth _____ Ear Length _____

Weight _____ Total Length _____

Neck Girth _____ Shoulder Height _____

Hind Leg Length _____ Antler Points: L _____ R _____

(Cont'd)

TREATMENTS

Radio Collar (channel no., frequency, color, etc.) _____

Neck Tag (color and number) _____

	Number	Color
Ear Tag: Right	_____	_____
Left	_____	_____
Blood Sample Yes/No ?	_____	Location _____
Rectal Palpation Yes/No	_____	Results _____
Fecal Samples Yes/No ?	_____	Comments: _____
Lactation Yes/No	_____	_____
		_____

ELK IMMOBILIZATION
REPORT CODES

Temperature (°C):
1 = -15+ to -10
2 = -9 to -5
3 = -4 to 0
4 = 1 to 5
5 = 6 to 10
6 = 11 to 15
7 = 16 to 20
8 = 21 to 25
9 = 26 +

Cloud Cover:
1 = clear sky
2 = scattered overcast (< 25% cover)
3 = broken overcast (25% < cover < 75%)
4 = few breaks in overcast (75% < cover < 100%)
5 = light overcast
6 = heavy overcast
7 = fog
8 = smoke

Precipitation:
1 = no precip.
2 = light rain
3 = heavy rain
4 = light snow
5 = heavy snow
6 = hail/sleet

Snow cover:
1 = no snow
2 = trace
3 = 1"-4" snow cover
4 = 5"-12" snow cover
5 = 13"-24" snow cover
6 = 25"-36" snow cover
7 = > 36" snow cover
8 = 1"-6" patchy
9 = > 6" patchy

Habitat:
1 = road
2 = recent clearcut (0-3 yrs)
3 = recent clearcut (4-10 yrs)
4 = recent clearcut (11-20 yrs)
5 = regenerating conifers 21+ yrs)
6 = mature conifer
7 = deciduous
8 = mixed conifer/deciduous
9 = riparian
10 = river/lake flats
11 = meadow/bog
12 = slide
13 = right of way
14 = cultivated field
15 = residual/advanced regen. pockets
16 = other (specify in comments)

Page _____ of _____

9.4 ELK RADIOLOCATION FORM

DATE: _____ INVESTIGATOR(S): _____

	1	2	3	4
TEMP. (code)				
CLOUD(")				
WIND (mph)				
PRECIP.(code)				
SNOW (")				

LOCATION	WEATHER	FREQ.	TIME	BEARING	ACCURACY (20/40/> 40)	ACTIVE/ INACTIVE	COMMENTS

ELK SIGHTING/RADIOLOCATION FORM

CODES

Temperature (°C):

1 = -15+ to -10
2 = -9 to -5
3 = -4 to 0
4 = 1 to 5
5 = 6 to 10
6 = 11 to 15
7 = 16 to 20
8 = 21 to 25
9 = 26 +

Cloud Cover:

1 = clear sky
2 = scattered overcast (< 25% cover)
3 = broken overcast (25% < cover < 75%)
4 = few breaks in overcast (75% < cover < 100%)
5 = light overcast
6 = heavy overcast
7 = fog
8 = smoke

Precipitation

1 = no precip.
2 = light rain
3 = heavy rain
4 = light snow
5 = heavy snow
6 = hail/sleet

Snow cover:

1 = no snow
2 = trace
3 = 1"-4" snowcover
4 = 5"-12" snowcover
5 = 13"-24" snowcover
6 = 25"-36" snowcover
7 = > 36" snowcover
8 = 1"-6" patchy
9 = > 6" patchy

Habitat

1 = road
2 = recent clearcut (0-3 yrs)
3 = recent clearcut (4-10 yrs)
4 = recent clearcut (11-10 yrs)
5 = regenerating conifers 21 + yrs
6 = mature conifer
7 = deciduous
8 = mixed conifer/deciduous
9 = riparian
10 = river/lake flats
11 = meadow/bog
12 = slide
13 = right of way
14 = cultivated field
15 = residual/advanced regen. pockets
16 = other/specify in comments.

Animal Activity

1 = crossed road
2 = standing watching observer
3 = took flight b/c of observer
4 = standing resting
5 = milling around
6 = bedded resting
7 = bedded ruminating
8 = feeding
9 = travelling
10 = fighting insects
11 = nursing
12 = seeking shelter
13 = playing
14 = aggression
15 = fled from unknown causes
16 = gradually moved out of sight
17 = other (see comments)

ELK RADIOLOCATION FORTRAN DATA CODES

DATA	COLUMNS	COMMENTS
(1) DATE	1-6	YR/MO/DAY
(2) TEMPERATURE	7	0 = no data 1 = -15+ to -10 2 = -9 to -5 3 = -4 to 0 4 = 1 to 5 5 = 6 to 10 6 = 11 to 15 7 = 16 to 20 8 = 21 to 25 9 = 26+
(3) CLOUD COVER	8	0 = no data 1 = clear sky 2 = scattered overcast (< 25% cover) 3 = broken overcast (25% < cover < 75%) 4 = few breaks in overcast (75% < cover < 100% 5 = light overcast 6 = heavy overcast 7 = fog 8 - smoke
(4) WIND	9-10	In mph (99= no data)
(5) PRECIPITATION	11	0 = no data 1 = no precipitation 2 = light rain 3 = heavy rain 4 = light snow 5 = heavy snow 6 = hail/sleet
(6) SNOW COVER	12	0 = no data 1 = no snow 2 = trace 3 = 1"-4" snow 4 = 5"-12" snow 5 = 13"-24" snow 6 = 25"-36" snow 7 = > 36" 8 = 1"-6" patchy 9 = 7"-24" patchy
(7) LOCATION	13-21	13-15 = Map Sheet (L=1; K=2) 16-18 = horizontal 19-21 = vertical
(8) FREQUENCY	22-25	LAST 4 DIGITS OF RADIO FREQUENCY RECORDED (ex. 151.081; 1081 recorded)
(9) TIME	26-29	2400 hr. time system

(Cont'd)

DATA	COLUMNS	COMMENTS
(10) BEARING	30-32	To nearest degree
(11) ACCURACY	33	0 = no data 1 = exact (observed location) 2 = 20 acre accuracy 3 = 40-acre accuracy 4 = > 40-acre accuracy
(12) ACTIVE/ INACTIVE	34	0 = no data 1 = Active 2 = Inactive

9.5 VEGETATION DESCRIPTION FORM

CODES

SPECIES COVERAGE:

1 = < 1%
2 = 1 - 1.9%
3 = 2 - 5%
4 = 6 - 10%
5 = 11 - 25%
6 = 26 - 33%
7 = 34 - 50%
8 = 51 - 75%
9 = > 76%

VIGOR:

0 = species dead
1 = vigor poor
2 = vigor fair
3 = vigor good
4 = vigor excellent.

DISTRIBUTION:

1 = rare individual, a single occurrence
2 = a few sporadically occurring individuals
3 = a single patch or clump of a species
4 = several sporadically occurring individuals
5 = a few patches or clumps of a species
6 = several well spaced patches or clumps
7 = continuous uniform occurrence of well spaced individuals
8 = continuous occurrence of a species with a few gaps in the distribution
9 = continuous dense occurrence of a species

_____ Location _____ Surveyor(s) _____ Plot # ____

Slope _____ Aspect _____

	STRATIUM												
cover code / vigor code	Veteran	A1 Dominant Trees	Main Canopy	A3 Trees	Total Trees	B1 Tall Shrubs	B2 Low Shrubs	Total Shrubs	C Herbs	D Mosses, Seedlings	% of individuals of a species browsed	% of browse on each individual	Comments
height top of stratus (m)					—			—					
percentage code													
species list													

PLOT COMMENTS: _____

VEGETATION DESCRIPTION FORTRAN DATA CODES

DATA	COLUMN	COMMENTS
PLOT IDENTIFICATION	1-6	1-2 = 2-letter area code (ex. SA = Sayward) 3-4 = transect # 5-6 = plot #
STRATA	7*	1=(A1) = dominant and codominant trees 2=(A2) = intermediate trees 3=(A3) = supressed trees < 10m. in ht. 4=(B1) = sapplings and shrubs 2-10m. in ht. 5=(B2) = shrubs >15cm.- 2m. in ht. 6=(C) = shrubs 15cm. and all herbs 7=(DH) = bryophytes, lichens and seedlings on humus 8=(DW) = bryophytes, lichens and seedlings on dead wood 9=(DR) = bryophytes, lichens and seedlings on rock
SPECIES	8-11	species code #
SPECIES COVERAGE	12-13	% cover code: 00 = no information 01 = < 1% 02 = 1-1.9% 03 = 2-5% 04 = 6-10% 05 = 11-25% 06 = 26-33% 07 = 34-50% 08 = 51-75% 09 = 76%+
DISTRIBUTION CODE	14	
	15-21	DATA FROM COLUMNS 8-14 repeated for next species.
	22-28	" "

* New line started for new stratum

9.6 Personnel Contacted

F. Bunnell - Department of Forestry, U.B.C. Vancouver, B.C.

M. Broren - MacMillan & Bloedel Ltd. Menzies Bay Division, Menzies Bay, B.C.

H. Langin - Ministry of Environment, 2569 Kenworth Rd., Nanaimo, B.C.